



# Department of Pesticide Regulation



Brian R. Leahy  
Director

## MEMORANDUM

Edmund G. Brown Jr.  
Governor

TO: Linda O'Connell  
Environmental Program Manager I  
Worker Health and Safety Branch

**HSM-13007**

FROM: Harvard R. Fong, CIH  
Senior Industrial Hygienist  
916-445-4211  
*(original signed by H. Fong)*

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SUBJECT: TREEHOLE FUMIGATION INFORMATION AVAILABLE FROM  
INDUSTRIAL HYGIENE SERVICES

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I have collected all the available information generated by Worker Health and Safety (WHS) industrial hygienists on the subject of treehole fumigation. This memorandum catalogs the various air sampling tests that were performed during 1997 and 1998 to gather data on worker exposure to methyl bromide during treehole applications and compiles earlier illness data collected from treehole application exposures to methyl bromide.

Broadly speaking, treehole fumigation is a procedure whereby fumigant gas (primarily methyl bromide) is injected into a relatively small volume of soil (<100 cubic feet) *in situ*. This is done in preparation of planting a tree or other woody plant into the spot, either as a replacement for a dead or underperforming tree or for a newly sited plant. Before application, the soil is usually "fluffed up" with a backhoe, auger or some other equipment to loosen the area of application. Treehole fumigations using methyl bromide became an issue for the Department in the late 1980's. At that time, the Director of the Department of Pesticide Regulation, Jim Wells, had been made aware that serious injuries, including severe chemical burns, had been connected to the use of methyl bromide during treehole fumigation. The Director requested that use information on treehole fumigations be gathered. At the time, Senior Industrial Hygienist Dennis Gibbons and I contacted Ed Hosada of Cardinal Chemical in Woodland as a potential cooperator for any monitoring projects. I also reviewed illness and injury reports concerning workers who would have direct contact with methyl bromide, either from direct exposure from recently treated soil, equipment leakage, or entrapment of surface-level residual vapor (i.e. inside boots). These work classifications included shovelers, tarpaulin removers and treehole fumigators. Table One, compiling these illness data, was generated from the review of data supplied by the Pesticide Illness Surveillance Program (PISP).

The greatest number of illnesses involving workers in direct contact with treated soil appeared to be associated with tree-hole fumigations, which also involves close contact with the actual point of injection. The events leading to these illness/injuries were usually probe or system failure. This included probe decoupling, hose/valve decoupling or failure, and dripping of residual (non-purged) material from the probe ("dripping"). A few cases of plugged probes, which workers tapped against their feet to dislodge the plug, resulted in liquid splashing on the worker's feet.



Soil back-percolation exposure was caused by workers tamping down soil around the probe insertion site. The upwelling methyl bromide would penetrate the shoes (usually leather or canvas) and cause severe skin dermatitis or burns.

**Table One: Selected Methyl Bromide Illness/Injury Events from 1984 through 2010\***

Activity	84-10*	Annual Mean
Shoveler	17	<1
Tarpaulin Remover	15	<1
Treehole Fumigation:	Total = 52	3.2
Steel probe clogged	3	<1
Soil back-percolation	4	<1
Probe/system failure**	29	1.8
1-pound can***	3	<1
Unknown	13	<1

\*shoveler/tarpaulin remover data from 1984 to 2002

\*\*includes non-purging of lines

\*\*\*one pound cans are believed to have been no longer available in the late 90's

Probe/system failures were the exposure event most associated with illness and injury. As such, WHS discussed the problems of probe-related exposure with Mr. Hosada. The construction of the probe in use at that time was nothing more than an iron pipe, perforated along the sides at one end and equipped with a hose fitting at the other end. The perforated end (perforated in the last 12 inches) could be open or blanked (sealed across the end with a metal plate). A cross-member may be welded on the fitting to allow a better grip when inserting the probe into the soil. The probe is connected to the methyl bromide source via flexible plastic tubing. The methyl bromide source tank will often be a large cylinder of methyl bromide/chloropicrin (99.5/0.5%, respectively) equipped with a smaller measuring bottle (also known as a metering bottle). The measuring bottle is used to meter out the 1 to 2 lbs. of gas from the main cylinder, after which the main cylinder is shut off and the measuring bottle is opened into the transfer line to the probe. After injection of the methyl bromide, the probe is removed from the soil. Any remaining methyl bromide in the line could potentially leak out onto the soil surface or the shoes of the applicator. This procedure can and does result in worker exposure, primarily during removal of the probe (dripping, back-percolation, residual gas-creep at the soil surface) but also in the use of non-reinforced hoses and inadequate clamps.

Two probe-modification designs were developed by Mr. Hosada. The first was an off-the-shelf injection probe used by structural treatment personnel for application of liquid pesticides into pre-drilled soil bores, referred to as the SPCO (Structural Pest Control Operator) probe. Mr. Hosada abandoned this approach as non-functional, since in-field testing of the SPCO probe

showed that it would rapidly compact with soil and become jammed. A second design ("Hosada" probe) was fabricated *de novo*, utilizing a spring-loaded ballcock valve near the injection end of the probe (to prevent soil compaction into the probe); a perforated probe head with bent nails loosely in the holes (to self-clear the perforations); and a valve control system to both seal the probe from any residual leakage from the measuring bottle and to allow use of a nitrogen or compressed air purge of the lines and probe before removal from the injection site. Both the SPCO and Hosada probes were tested in-field by either Mr. Hosada or another employee of Cardinal Chemical, using a small number of application sites (from 4 to 10 treehole injection sites) and air monitoring of select areas of the applicators body. Additionally, sampling was performed on a test site using the standard "iron pipe" probe. Results of these tests are shown in Table Two.

**Table Two: Methyl Bromide Air Concentrations Associated with Different Injector Probes During Treehole Fumigation**

Sample Location	Iron Pipe <sup>1</sup>	SPCO Probe <sup>2</sup>	Hosada Probe <sup>3</sup>
	PPM of Methyl Bromide		
OBZ <sup>4</sup> Left Side	NA <sup>5</sup>	NS <sup>6</sup>	ND <sup>7</sup>
OBZ Right Side	6.8	NS	ND
Right Leg	70.5	NS	17
Left Leg	NA	NS	4.0
Probe	272.6	92.7	0.82
Controls	ND	NS	ND

<sup>1</sup> 45 minute sample

<sup>2</sup> 20 minute sample

<sup>3</sup> 15 minute sample

<sup>4</sup> OBZ = Operator breathing zone

<sup>5</sup> NA = Not applicable, air sampling only on one side.

<sup>6</sup> NS = No Sampling

<sup>7</sup> ND = None Detected <0.073 PPM

Personal air samples were not drawn for the SPCO probe study since it was obvious that leakage was occurring from the unit and was not going to be a viable alternative to the existing iron pipe method. The iron pipe probe resulted in unacceptable levels of exposure. The Hosada probe appeared to reduce potential methyl bromide exposure to acceptable levels, but upon further work by Mr. Hosada, he noted that it also developed soil compaction/infiltration problems and has been abandoned. Presently there are no other probe designs under investigation.

The use of the treehole method for methyl bromide application was originally designed for spot treatment of areas where a tree or vine had been removed and the soil needed localized treatment in preparation of a replanting. Any large-scale application of this method to entire fields (defined here as more than one acre) would, according to the data presently available, result in unacceptable exposure to applicators. Given the 45 minute exposure of 6.8 ppm listed in Table

Two, and assuming no further exposure afterwards, the 8-hour time weighted average (TWA) exposure to the employee was 0.63 ppm. Even then, retrospectively the applicator would be required to wear respiratory protection since the exposure was above 5 ppm. A typical methyl bromide label does not appear to treat 5 ppm as a TWA, but more as a ceiling value that may not be exceeded. The following are examples of language found on methyl bromide cylinders used for fumigation:

“A respirator is required if the acceptable air concentration of 5 ppm is exceeded at any time” (Brom-O-Gas 2%, Meth-O-Gas 100%);

“A respirator is required if the acceptable air concentration level of 0.1 ppm for chloropicrin or 5 ppm for methyl bromide is exceeded at any time” (Terr-O-Gas 98);

“If this concentration (5 ppm) is exceeded at any time, all persons in the fumigation area must wear a NIOSH/MSHA approved self-contained breathing apparatus (SCBA) or combination air-supplied/SCBA respirator or evacuate the area” (Brom-O-Gas 0.25%).

During September of 2005, an informal information request on county restrictions for treehole fumigations was e-mailed to select personnel in the Enforcement Branch. Enforcement personnel were queried as to what restrictions, if any, the local agricultural commissioners have placed on treehole fumigation procedures. The responses run the gamut from no treehole fumigations performed (Inyo/Mono, Sonoma, Amador, El Dorado, Mariposa, San Luis Obispo) to only minor use and no specific restrictions (San Joaquin, Tulare, Kings) to minor use and restrictions (San Diego, Kern) to potentially major use and restrictions (Stanislaus, Merced). Restrictions include only spot treatment (no whole-field use), pre-application site inspection, minimum wind velocities and treatment for replant in existing fields only. It may be useful to develop a formal inquiry into all the counties handling of treehole fumigation procedures.

#### Conclusions/Recommendations

The use of probes in treehole fumigation presents hazards that may not be easily remediated by engineering controls. Even using air-purging of lines before withdrawal from the soil depends on operators allowing sufficient time for line purging before probe removal. Further development of probe insertion/withdrawal systems, including complete mechanization of the procedure to remove operators from the general area of the application, is strongly suggested. A combination auger/injector, mounted on its own trailer and using a tractor power take-off, may be a possible engineering solution to handler exposure. Another potential mitigation of exposure may be the use of one pound cans that can be fitted with a puncturing device, buried with a puncture actuator, and then punctured underground, withdrawing only the actuating device (solid metal rod) to prevent direct employee exposure to methyl bromide drippage. This, of course, would depend on the availability of such containers.